both radiations. Clustered DNA damage poses serious problems for the DNA repair and error-prone repair of DNA damage is associated with cancer induction. Increased damage complexity following exposure to mixed beams will suggest a higher than expected risk of cancer induction in modern radiotherapy. The results are consistent with the previous studies carried out at SU with different cell types and different biological assays. A synergistic interaction of the beam components was observed at the level of micronuclei, gammaH2AX foci and chromosomal aberrations.

EP-2073

Angio/lymphangiogenic, inflammatory and immune responses in head and neck cancer: proton vs photon

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Purpose or Objective: Due to its higher precision in tumor targeting, proton therapy could become the treatment of choice for head and neck cancer (HNC). Recent studies have shown that proton irradiation suppresses angiogenic genes and impairs tumor cell invasion/growth. According to the type of radiation, dose and fractionation, the objective of our study was to investigate the effect of proton (P+) versus photon (X) irradiations in squamous cells carcinoma (SCC), in respect of their proliferation, genes expression and proteins secretion involved in proliferation, angio/lymphangenesis, metastasis and anti-tumor immunity.

Material and Methods: Human SCC CAL33 cells were irradiated 1 to 3 times and evaluated on their proliferation (Cell counting), genes expression (qPCR) for proliferation (TRF2, PLK1), angio/lymphangiogenic (VEGF-A, VEGF-C, VEGF-D) inflammatory (IL6, IL8, CCL2, CXCL12) and immune (PD-L1) responses.and protein synthesis (ELISA).

Results: Cell proliferation was evaluated at 48h and at 3 weeks after 1 irradiation and showed a significant decreased in both X and P+, as compared to control but more important in P+. After 3 irradiations, cell proliferation at 48h was reversed and more decreased in X vs P+. Genes expression was investigated at 48h after 1 and 3 irradiations at 2 and 8 Gy. After 1 irradiation, the prevalence of gene expression levels associated with a poor outcome was higher in X than P+ at 8 Gy. After 3 irradiations, genes expression was increased for all but more important for P+ at 8 Gy. The highest expression was noted for VEGF-C (2 to 10 fold increase). The most frequent overexpression was noted for PD-L1. VEGF-C protein induction 48h after 1 and 3 irradiations was increased in both X and P+ groups but decreased in high dose P+, as compared to X.

Conclusion: Cell proliferation activity is in favor of P+ after a single irradiation, and X after multiple irradiations. Genes expression are overall increased in both X and P+, in a dose and fraction dependent manner, implicated in proliferation (TRF2), angio/lymphangiogenic (VEGF-A, VEGF-C, VEGF-D) and immune (PD-L1) responses. VEGF-C protein induction is increased after both X and P+ single and multiple irradiations, but in favor of P+, suggesting a lower lymphangiogenesis/metastatic dissemination immediately after P+. Our study sets the molecular basis for novel therapeutic approaches applicable to HNC in combination with X or P+ radiotherapy, such as angio/lymphangenic inhibitors or immune therapy as anti-PD1 or anti-PD-L1.

Electronic Poster: RTT track: Strategies for treatment planning

EP-2074

The comparison of properties for radiotherapy with flattening filter-free and flattening filter beam

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Purpose or Objective: The aim of this study was to appraise multiple properties for radiation therapy techniques applying flattening filter-free (3F) and flattening filter (2F) beam to the radiation therapy.

Material and Methods: Alderson rando phantom was scanned for computed tomography images. Treatment plans for intensity modulated radiation therapy (IMRT), volumetric modulated arc therapy (VMAT) and stereotactic body radiation therapy(SBRT) with 3F and 2F beam were designed for prostate cancer. To evaluate the differences between the 3F and 2F beam, total monitor units (MUs), beam on time (BOT) and gantry rotation time (GRT) were evaluated and measured with TrueBeam™ STx and Surveillance And Measurement (SAM) 940 detector was used for photoneutron emitted by using 3F and 2F.

Results: In using 3F beam, total MUs in IMRT plan increased the highest up to 34.0% and in the test of BOT and GRT, the values in SBRT plan by 3F beam decreased the lowest 39.8, 38.6% respectively. The values of photoneutron occurrence in SBRT plan using 3F beam decreased the lowest 48.1%.

Conclusion: According as the results, total MUs increased by using 3F beam than 2F beam in all treatment plans but BOT, GRT and photoneutron decreased by using 3F beam. From above the results, using 3F beam can have an effect on decreasing intra-fraction setup error and risk of radiation-induced secondary malignancy.

EP-2075

Evaluation of conventional versus IMRT based Prophylactic Cranial Irradiation treatment planning

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Purpose or Objective: Patients with Small-Cell Lung Cancer (SCLC) have a high risk of developing brain metastasis. Prophylactic Cranial Irradiation (PCI), is applied to SCLC patients that response to chemotherapy. It is well known that PCI is associated with an increase in median overall survival. There are approximately 84 incidences per year in central region DK. Radiotherapy (RT) to this group of patients is conventionally performed using opposed MLC defined static fields. However, treatment planning can be time consuming. The aim of this study is to evaluate time-effectiveness, by changing the treatment technique from conventional to IMRT based treatment planning of PCI patients.

Material and Methods: This retrospective study included twenty SCLC patients, all treated with conventional planned PCI. Each patient received 25 Gray in 10 fractions. An IMRT template was made (Eclipse Version 11.0, Varian Medical Systems, Palo Alto, CA) and for each patient an IMRT plan was generated by one IMRT optimization. One intermediate dose calculation was performed during optimization before the final dose calculation. The contoured structures used for comparison between IMRT and conventional planning were: ITV, PTV and left/right lens. The plans were evaluated and compared on; max- and minimum doses, the mean/maximum doses to the lenses, and the homogeneity index (HI). The HI was defined by D5%/D95%. Quality assurance of the IMRT plans was performed by recording Portal Dosimetry Images

(PDI) for ten of the plans, and by independent dose calculation checks using RadCalc (RadCalc Version 6.2, LifeLine Software Inc, Tyler, USA).

Results: The observed differences between the conventional and the IMRT plans were limited. In average the maximum dose was 0.3 percentage points (pp) lower for IMRT than for conventional plans. The ITV coverage was better for the IMRT plans, with an average ITV minimum dose of 95.9 % compared to 94.1% (+1.8 pp). However, the PTV coverage was slightly worse for the IMRT plans, a decrease of 0.4 pp in V95%. The only relevant organs at risk are the lenses, were the maximum dose on average were lowered 0.3 Gray and the mean dose on average was lowered 0.1 Gray. The average HI for the IMRT plans was 4.0 while 5.1 for the conventional plans. The 10 PDI measurements were all accepted with a reference gamma index value of 5% dose agreement within 3 mm distance to agreement, and no further measurements were performed. Independent dose calculation checks were performed for QA. The time spend on treatment planning was approximately 20 minutes for IMRT plans and could easily be up to 3 hours when using the conventional technique.

	Property	Conventional	IMRT	Difference (Conv. – IMRT)
BODY	Maximum dose	106.4 %	106.1 %	-0.3 pp
ITV coverage	Minimum dose	94.1 %	95.9 %	+1.8 pp
PTV coverage	V95%	99.6 %	99.2 %	-0.4 pp
Lenses	Maximum dose	4.0 Gy	3.7 Gy	-0.3 Gy
	Mean dose	2.8 Gy	2.7 Gy	-0.1 Gy
Homogeneity	D5% / D95%	5.1	4.0	-1.1

Conclusion: It was possible to significantly reduce the time spend on dose planning by changing the treatment technique from conventional to IMRT for PCI patients while attaining comparable dosimetric quality of the treatment plans. Furthermore, both the treatment time and the time spend on quality assurances are comparable for the two techniques.

EP-2076

Stereotactic body radiation therapy using Tomotherapy for refractory metastatic bone pain: case study

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Purpose or Objective: To illustrate the technique and outcome of stereotactic body radiation therapy (SBRT) using Tomotherapy for refractory bone pain from metastatic disease. Tomotherapy SBRT planning parameters and dosimetric evaluation are outlined.

Material and Methods: In 2013, a 70 year old female patient presented with metastatic non-small cell lung carcinoma, following resection of lung primary in 2012. CT and MRI confirmed a lytic lesion on right of sacrum. Patient's sacrum initially treated with 30Gy/10Fx. Pain recurred 2 months post RT and managed by palliative care. 6 months post RT patient returned for consideration of re-treatment. Pain was refractory to everything apart from 15mg of oxycodone every hour. RO discussed the patient and risks of re-irradiation within the multidisciplinary setting. The consensus was to offer the patient SBRT, 24Gy in 3 fractions to the sacrum.
Helical Tomotherapy was used to plan and treat patient. The irregular PTV volume was 201.12cm3. Dose volume constraints included: colon (0.035cc<18.4Gy, 20cc<14.3Gy), sacral plexus (0.035cc<11Gy, 5cc<7Gy), cauda equina (0.035cc<16Gy, 5cc<14Gy), and skin (0.035cc<26Gy, 10cc<23Gy). No hotspots were to be located over the nerve roots.

Results: Tomotherapy planning parameters included field width of 2.5cm, pitch of 0.2 and a modulation factor of 1.5. Beam on time was 400.3 seconds. PTV coverage statistics were D99 = 22.5Gy (93.75%), V95 = 98.57%, VTD = 90.53%, Median = 25.37Gy (105.71%), D1 = 27.8Gy (115.83%). OAR dose included colon 0.035cc = 8.1Gy, 20cc = 6.8Gy; sacral plexus 0.035cc = 27.3Gy, 5cc = 25.3Gy; cauda equina 0.035 = 26.2Gy, 5cc = 21Gy; skin 0.035cc = 15.4Gy, 10cc = 12.3Gy. The conformity index statistics were R100% = 0.97, V105% outside PTV = 2cc, R50% = 4.21, Dmax > 2cm from PTV = 16.45Gy (68.5%).
One week post SBRT, patient's pain stable and mobility improving. Whole body bone scan 2 months post SBRT showed decreased activity and size of sacral lesion. 4 months post SBRT patient returned with significant left sacral pain with concern of further metastatic disease. PET confirmed no uptake in left sacrum. Pain associated with insufficiency fracture with cause unknown, SBRT or bone metastasis likely contributors. 5 months post SBRT patient improved dramatically, completely ambulant with PET/CT showing no evidence of recurrence/metastatic disease. 13 months post SBRT, patient remains asymptomatic, CT shows no evidence of metastatic disease.

Conclusion: This case study illustrates how the use SBRT can result in pain control for patients with refractory metastatic bone pain where there may be no other options available apart from palliative care, even in cases where the treatment volume is relatively large. This data is also informative since the patient shows no definite evidence of metastatic disease. Further studies could lead to improved therapies for the control of metastatic bone pain.

EP-2077

A decision protocol to propose proton versus photon radiotherapy: in silico comparison

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Purpose or Objective: Proton therapy cancer treatment offer potential clinical advantages compared with photon radiation therapy for many cancer sites. However, the treatment cost with proton is much higher than with conventional radiation. The objective of this study is to discuss how to improve a procedure, already described by others worldwide, to provide quantitative clues to select the patient for proton treatment instead of photon.

Material and Methods: The respective medical and clinical benefits of proton and photon therapy are assessed by in silico comparison following four successive steps. First, the dosimetric analysis is made using parameters derived from dose volume histogram (DVH) for target volume and organs at risks. Second, the DVHs are exported from TPS to calculate TCP and mostly NTCP radiobiological indexes. In the third step, a statistical comparison is done using non-parametric test to calculate p-value, then bootstrap method is used to estimate the confidence intervals including the lower and upper limit of agreements. Then the correlation between data from proton and photon treatment planning is assessed using Spearman's rank test. Finally, the cost-effectiveness and quality adjusted life years (QALYs) can be used to measures the outcome of the therapy and check if the therapeutic gain of proton therapy worth the increased expenses of it versus photon.

Results: The results with in silico data can be taken into account to make a proposal of a decisional procedure. The dosimetric and radiobiological analysis can be used to check the medical benefit with either proton or photon. The statistical tests allow to check if the dosimetric or radiobiological benefits for a specific patient can be included in the confidence interval of agreement of a representative population, the most homogenous possible. A Markov model can be used to simulate the life of patients treated with proton / photon radiation. The virtual evaluation may indicate for which cancer sites proton therapy could be more cost-effective than photon therapy.

Conclusion: The introduction of model based clinical trials with the possibility of individual assessment is a coming approach well adapted to the fast improvement of medical technology. The presently rising offer of proton therapy is a good example. The QALY concept based on objective dosimetric and clinical expected / modelized outcome may be a valuable response to this new challenge. However, large